Amendments to the Drawings:

The attached sheet of drawings includes changes to Figure 12. This sheet, which includes Figures 11 and 12, replaces the original sheet including Figures 11 and 12.

Attachment: Replacement Sheet
Annotated Sheet Showing Changes

REMARKS

This amendment is being filed concurrently with a Request for Continued Examination (RCE). Although the office action summary sheet states that the office action is "non-final," the examiner's comments state that the action *is* final. It is therefore assumed that the indication on the office action summary sheet was an inadvertent error, and that the examiner intended the action to be final. As such, an RCE is being filed herewith. If this assumption is incorrect, and the action was intended to be non-final, the examiner is respectfully requested to contact the undersigned at the earliest opportunity.

Claims 38-47 were rejected under 35 U.S.C. §112, first paragraph, as failing to comply with the written description requirement. In particular, the examiner found that the specification fails to give adequate teaching of several claim elements including the definition of "depth of field (D)," the relationship between "luminosity" and an inverse length measurement, and other equations and relationships recited in Claims 38 and 43. Indeed, the examiner has emphatically stated that equations in the rejected claims "are completely wrong." In addition, the examiner has rejected the applicants' arguments regarding the meaning of mathematical symbols used in the claims.

While the applicants do not agree with all of the examiner's conclusions regarding the mathematical relationships recited in the application, it has been noted that the teachings of several important principles of the applicants' invention do not depend on such mathematical relationships. As such, the aforementioned elements of Claims 38 and 43 have been removed from the claims by amendment, thereby obviating this basis for rejection. Reconsideration of Claims 38-47 under this ground for rejection is therefore respectfully requested.

Claims 38-47 were also rejected under 35 U.S.C. §112, first paragraph, as not being enabling. The stated grounds for this rejection is that the examiner found the mathematical expressions in question to be "physically impossible," and concluded that they are therefore not enabled by the specification. Since the equations have been removed from the independent claims by amendment, this basis for rejection has been obviated, and reconsideration of the rejected claims under this ground for rejection is respectfully requested.

The examiner has also stated that the specification fails to teach how auto-stereo three-dimensional views could be enabled by a computer-processed image and a barrier screen. However, the applicants' disclosure clearly explains in detail the fundamental principles of the auto-stereoscopic apparatus of the invention, so it is unclear to what the examiner is referring. If this is an extension of the basis for rejection involving the mathematical equations, the rejection has been obviated by the removal of those equations from the claims, and reconsideration is respectfully requested. If, however, the examiner is stating that the fundamental operation of the applicants' apparatus is not clear from the specification, then the applicants respectfully request that the examiner clarify this assertion, since the specification provides a detailed explanation of the operational aspects of the invention.

Claims 38 and 47 were rejected under 35 U.S.C. §112, second paragraph, as being indefinite. Because the examiner refers to the same mathematical expressions as discussed above when making this rejection, it is presumed that it the rejection was intended to apply to each of Claims 38-47, since Claims 39-42 depend from Claim 38 and Claims 44-47 depend from Claim 43, and these dependent claims inherit all of the limitations of their respective parent claims. Moreover, since the mathematical expressions have been removed from these claims by amendment, this basis for rejection has also been obviated, and reconsideration of the claims under this basis is therefore respectfully requested.

The drawings were objected to by the examiner. In particular, it was found that the "depth field (D)" was not shown in the drawings. In addition, the examiner refused to accept the drawing changes made with the applicants' last response in which a label for the depth field was added. As discussed above, the "depth field (D)" has been removed from the claims by amendment, and this basis for objecting to the drawings has therefore been obviated. Moreover, a new drawing replacement sheet for Figures 11 and 12 is being submitted herewith that removes the depth field reference that was added in the last drawing change, thereby reverting the drawings to their original state. Reconsideration of the drawings under this ground for rejection is therefore respectfully requested.

Claims 38-47 were rejected under 35 U.S.C. §103(a) as being obvious over U.S. Patent No. 5,953,148 ("Moseley") in view of U.S. Patent No. 5,949,390 ("Nomura"). In making this rejection the examiner has stated that Moseley teaches all of the elements of the applicants' claims except for the feature of having apertures in a parallax barrier that are comprised of a plurality of rows of staggered apertures. The Moseley reference is therefore combined with Nomura, which the examiner states teaches the use of a parallax barrier with a plurality of rows of staggered apertures to be aligned with staggered image cells "for the benefit of reducing the possible intensity variation caused by the *black lines* separating the image cells."

Moseley discloses a spatial light modulator and directional display that provides an autostereoscopic 3D image and, more particularly, LCD-based displays that use a liquid crystal device located behind a lenticular screen. Within the scope of this type of display device, Moseley discloses a variety of different types of display configurations, each of which uses a plurality of pixels aligned in a pattern on the display. The pixels are arranged such that electrical conductor paths may pass between them, as is necessary for supplying electrical signals to each of the pixels. The lenticular screen provides the necessary redirection of light from the pixels to the various viewing positions, allowing different views to be presented at different viewing positions. This enables a three-dimensional effect to be provided to a viewer.

As noted by the examiner, Moseley also discloses an embodiment in which a parallax barrier is used as a "view defining optic." The use of the barrier enables a pixel arrangement to be used in which there are relatively small gaps between adjacent pixel columns. The examiner makes particular reference to Figure 15b of Moseley, in which a parallax barrier is clearly shown. Notably, however, this device is used in combination with "observer tracking," which detects movements of an observer, and responds by mechanically moving the parallax barrier in the directions of arrows 30 and 31. In this way, the observer is prevented from leaving the "viewing windows" of the device, thereby avoiding the visual artifacts that would otherwise be present.

The examiner also makes specific reference to column 11, line 63 through column 12, line 19 as well as Figure 18 of Moseley. In particular, the examiner states the following:

> Moseley teaches that the image pixels on the spatial light modulator or the liquid crystal display can be arranged in *staggering shapes* with *black mask* interposed between the staggered shaped pixels to maximize the display resolution by reducing the cross-talk i.e. to reduce light from neighboring regions to leak through the viewing window. The black mask provides the *dark rippled lines* that alternates between the top and bottom portion of the lower and upper rows among the pixels.

This paraphrase of Moseley, however, seems to blur together two different disclosed embodiments. Figure 17 is described in column 11, line 63 through column 12 line 9, and the text of this section does, indeed, refer to "continuous vertical black strips, such as 35," of the "black mask" 5. However, this is separate and distinct from the embodiment of Figure 18, which uses a much different pixel shape, and which is described in column 12, lines 10-19 of Moseley. In the Figure 17 embodiment, the black mask 5, which is previously mentioned in column 2, lines 25-26, is a means by which the pixel shapes may be defined. The pixel shapes of Figure 17 are roughly rectangular, and are widely separated in the horizontal direction. Thus, there are "vertical black strips" 35, that is, wide black regions separating the pixel columns, as indicated by the arrow 35. In the corresponding text of the disclosure, Moseley states how these wide black strips reduce cross-talk permeation. However, there appears to be no mention of "staggered shaped pixels" with regard to this embodiment, and certainly no "dark rippled lines" as has been suggested by the examiner.

The embodiment of Figure 18 (immediately identified by Moseley as "another pixel arrangement") makes use of pixels having a hexagonal shape. The pixels have a "rectangular central portion" that does not overlap with adjacent pixels in the same row, and "triangular end portions" that do overlap with pixels in the same row. Moseley goes on to explain that "[a]djacent pairs of pixels in the same row are vertically offset with respect to each other." In this embodiment, there are gaps that separate the pixels in the vertical and horizontal dimensions. However, the pixels overlap with each other, and there is no mention of any "vertical black strips" to reduce cross-talk, as is the case in Figure 17. Indeed, as the pixels overlap with each other in the vertical direction, it would not be possible to provide such wide, straight separating regions. Thus, it appears that the examiner has conflated two different embodiments and that there is actually no suggestion of "dark rippled lines."

Nomura discloses a three-dimensional display apparatus that, like Moseley, is based on the use of a liquid crystal display. A display panel 1 is used in combination with a "slit panel," which includes a plurality of slits arranged in a zig-zag pattern. Nomura explains that:

> [b]y placing the slits in the slit panel 2 in a zig-zag manner, the number of sampling points in a horizontal direction increases as compared with that of the slit pattern of the conventional slit array panel. As a result, the deterioration of resolution in the horizontal direction can be reduced.

Nomura goes on to describe several variations of slit patterns, each of which has slits in offset positions from one column to the next. However, each of the disclosed embodiments appears to focus on the shape and arrangement of the barrier slits.

In citing Nomura, the examiner stated that it disclosed "a parallax barrier with a plurality of rows of staggered apertures or slits to be aligned with staggered image cells for the benefit of reducing the possible intensity variation caused by the *black lines* separating the image cells." Continuing, the examiner argues that Figures 2, 3A and 4 show that there are black lines separating staggered image pixels, and that it would have been obvious "to apply the teachings of Nomura et al. to modify the *parallax barrier* of Moseley et al. accordingly..." This argument is confusing in several respects.

With regard to the examiner's contention that Nomura discloses black lines between image cells, it is agreed that the schematic drawings of Figures 3A and 3B of Nomura use black lines to delineate different regions of the liquid crystal panel. However, there appears to be no suggestion that actual black lines are used on the panel surface. In Figure 1, the panel 1 is shown and there are clearly no black lines on its surface. Moreover, in the enlarged, isolated view of Figure 3B, black lines are used to show the reader that there are different pixels within a pixel group but, notably, no corresponding black lines appear in Figure 3A, thus indicating that the lines are for explaining the invention to the reader, and are not actually present on the panel surface. In a similar context, black lines are used for shading one of the pixel groups in Figure 3A, but it is obvious that such lines do not actually exist on the surface of the panel. There is no suggestion that "black lines" are used to separate the image cells on the panel, as argued by the examiner. One skilled in the art would be much more likely to see the lines in Figures 3A and 3B as being used simply to demonstrate pixel and pixel group locations to the reader.

Notwithstanding the above, the present invention is quite different from the cited prior art in various ways. One notable distinction is the cell structure of the applicants' image. This cell structure is clearly shown in Figure 7 of the present application. As shown, each cell is substantially hexagonal in shape with a maximum height in a first (*e.g.*, vertical) direction that is centered relative to the cell. In the perpendicular direction, this cell height tapers continuously to a minimum height at the extremes of the cell. This tapering effect is acceptable as the information near the extremes of the cell corresponds to views that are at a relatively acute angle relative to the surface of the image. For a viewer whose point of view moves roughly parallel to the surface of the image, the distance between the viewer and the cell increases as the point of view angle becomes more acute. This increased distance reduces the size of the region that may be viewed through an aperture adjacent to a cell as the angular viewing range of the observer is reduced. Thus, the tapering of the cells toward the extremes results in a negligible loss of information, based on a lateral movement of the viewing position. However, this tapering also provides the present invention with a significant advantage.

In the applicants' invention, the cells of the image are contiguous with horizontally adjacent cells so as to form cell rows. These cell rows also lie adjacent to each other in the first (*e.g.*, vertical) direction, with cell positions being staggered in the second (*e.g.*, horizontal) direction from one row to the next. The hexagonal shape of the cells is such that it allows the maximum cell height in one row to align with the minimum cell height in an adjacent row. That is, as shown in Figure 7, the cells in adjacent rows fit neatly together to allow a tight organization of cells in the image. This, in turn, fits neatly with the staggered arrangement of apertures as is shown in Figure 4. While the staggered aperture arrangement may be beneficial for other reasons, the cell configuration of the present invention also allows more apertures to be used as they are spaced more closely together than in prior art image arrangements. This higher density of cells and apertures, in turn, permits more light and more information to reach the viewer from the image, thereby increasing the luminosity and the quality of the image perceived by a viewer.

The cell configuration of the present invention is particularly effective in the area of still images, which are typically backlit. To create a high quality three-dimensional representation, many different views must be incorporated into the image so that the change in viewing position provides a viewer with a smooth transition from one view to the next. Increasing the number of views, however, reduces the amount of image information being provided for each view. The present invention maximizes the amount of information provided to a viewer by providing a tight arrangement of cells, with little or no wasted image space. As is apparent from the shape of the cells, the vertical informational range is reduced for the extreme viewing angles, but the overall loss is minimal. Since the horizontal movement of a viewer's position is most often parallel to the image surface, the distance from a viewer's eye to a particular cell (and its corresponding aperture) increases as the viewing angle increases relative to an axis normal to the image surface. This, necessarily, reduces the portion of the image that can be seen through the aperture in question, and thus allows a reduction of the cell height at the cell extremes with no appreciable loss of viewable information. However, by providing a denser arrangement of cells and, correspondingly, a denser arrangement of apertures, more overall information, and more overall light, is provided to the viewer as a result of the applicants' cell configuration.

In order to better highlight the cell structure of the applicant's invention, independent Claims 38 and 43 have been amended to carefully define the configuration of an image according to the present invention. In particular, the claim has been modified to more clearly recite the structure of the cells that make up the image, as is shown in the applicants' Figure 7. As amended, Claims 38 and 43 now refer to an image comprising a plurality of views made of pixels organized in a plurality of cells. The cells are of equal size and shape, and each contains image information corresponding to a predetermined range of views for a region of the image in which the cell is located. Thus, as described in paragraph [040] of the applicants' disclosure, and shown in the corresponding Figure 3, a relationship is created between points of view 10a to 10d and corresponding information 9a to 9d on the computer-processed image. Since one slit corresponds to one cell of the image, each cell contains information corresponding to a plurality of views. However, the cell structure is also used to optimize the image quality.

As now recited in Claims 38 and 43, each cell is substantially hexagonal in shape with a maximum height in a first (*e.g.*, vertical) direction that is centered relative to the cell, as shown in Figure 7. In the perpendicular direction, this cell height tapers continuously to a minimum height at the extremes of the cell, again as shown in Figure 7. As discussed above, this tapering effect is acceptable as the information near the extremes of the cell corresponds to views at a relatively acute angle relative to the surface of the image, and it also provides the present invention with a significant advantage. As the cells of the image are contiguous with horizontally adjacent cells so as to form cell rows, and these cell rows also lie adjacent to each other in the first (*e.g.*, vertical) direction, the cells in adjacent rows fit neatly together to allow a tight organization of cells in the image. This allows more apertures to be used as they are spaced more closely together than in prior art image arrangements, and permits more light and more information to reach the viewer from the image.

Nowhere in the prior art combination of Moseley and Nomura is there any suggestion of using an image with a cell structure as is recited in Claims 38 and 43. Claims 39-42 depend ultimately from Claim 38 and Claims 44-47 depend ultimately from Claim 43, and these claims are therefore equally unsuggested by the cited prior art. Reconsideration Claims 38-47 under this ground for rejection is therefore respectfully requested.

In paragraph 10 of the office action, the examiner states that Claims 38-47 were rejected under 35 U.S.C. §103(a) as being obvious over Nomura in view of Moseley. As the cited prior art combination appears to be identical to that cited in paragraph 9 of the office action, and is applied to the same group of claims, it is unclear why this section has been set off as a separate paragraph. Many of the comments in paragraph 10 also appear to be the same as presented earlier in paragraph 9. Assuming the inclusion of this additional paragraph was not inadvertent on the part of the examiner, the applicants' therefore point out that the same reasons as provided above in response to the rejection of paragraph 9 apply to this section as well. That is, there is no suggestion in the prior art combination of Moseley and Nomura of an apparatus as recited in the applicants' Claims 38-43, as amended. As such, reconsideration of these claims under this ground for rejection is respectfully requested.

Claims 39-42 have been amended to correct a clerical error in which they referred to an apparatus rather than a method. In addition, Claims 41 and 46 have been amended to specify that each aperture is aligned with a part of an adjacent cell in which the cell has said maximum height, as is clearly indicated in applicants' Figure 7.

Claims 44 and 45 have been added to provide claim coverage for the limitation of the dark separation lines between the cell rows in the applicants' image, which was removed from claims 38 and 43, respectively. The use of these separation lines, which provide small dark regions separating the cells in a vertical direction, reduces the likelihood of vertical distortions in the viewed image. As discussed above, there is no suggestion of dark lines such as these in the cited prior art combination. Acceptance and allowance of these claims is respectfully requested.

In light of the foregoing amendments and remarks, it is respectfully requested that all the claims be allowed such that the application may be passed to issue. If it is believed that a telephone conference will help expedite prosecution of the application, the examiner is invited to call the undersigned.

Respectfully submitted,

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Attachments